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ABSTRACT

The teacher's guide and student materials provide elementary and junior high school students with an understanding of the space shuttle as a new kind of transportation for conveying goods and performing services in space. The unit is appropriate for a learning center approach, individual instruction, or use with the entire class. It is organized into two sections. In section one the student learns the main part of the shuttle. Section two deals with the uses of the shuttle and how it will be beneficial to consumers. Students label the parts of an orbiter on worksheets, write newspaper stories, analyze the necessity for recycling, examine the contributions of the shuttle, design a factory to be built in space, and locate companies assigned to manufacture various parts of the shuttle. Other activities include defining terms related to the shuttle and reading an article, "Moonwalk and Beyond" by Isaac Asimov. The teacher's guide includes objectives, materials needed, reproducible activity sheets, and pre- and posttests with keys. (KC)

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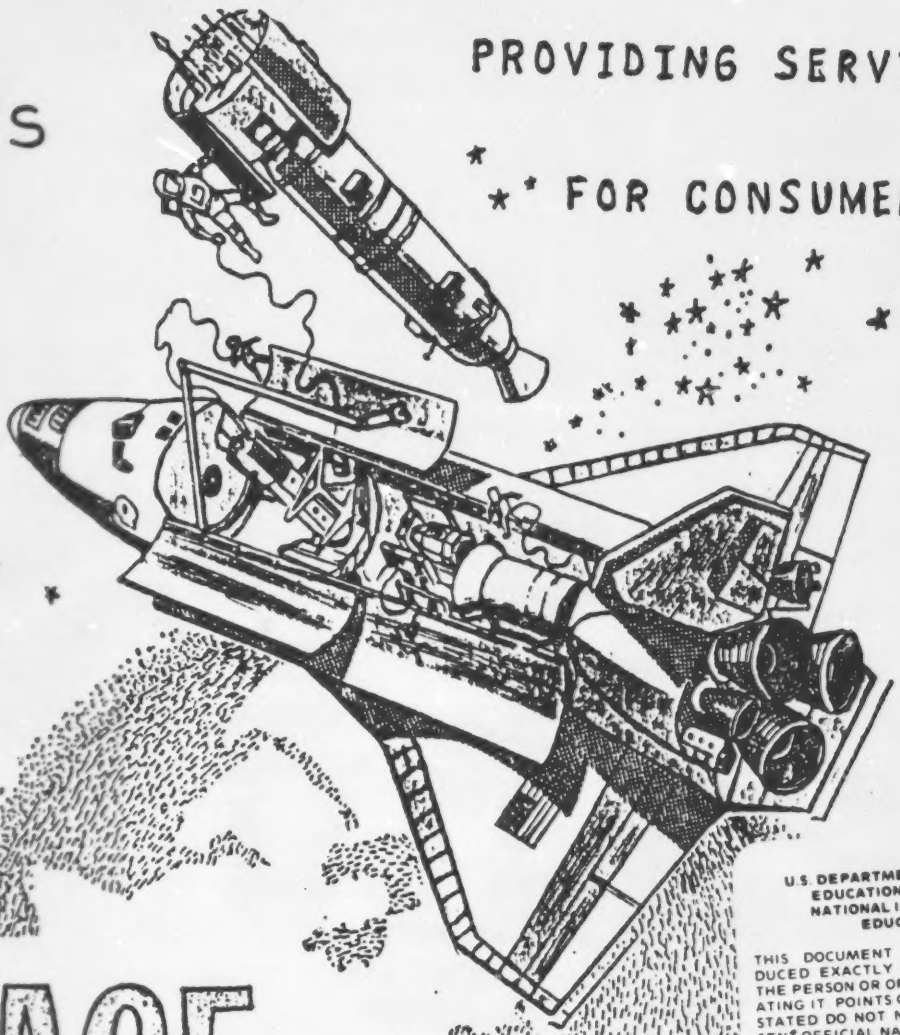
A NEW TRANSPORTATION SYSTEM

PROVIDING SERVICE

FOR CONSUMERS.

Teacher's

Guide



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SPACE SHUTTLE

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Written By:
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Easton, KS 66020

TABLE OF CONTENTS

Space Shuttle Given a Push 1

Package Resume Form 2

Objectives 3

Special Instructions and Suggestions 4

Materials List for Space Shuttle Capsule 6

Shuttle Can Do 6

Activities 7

Pre-test Key 9

Post-test Key 12

Bibliography 15

Appendix 16

- Pre-test
- Section I Student Space Log
- Mission #3 Worksheet
- Mission #4 Worksheet
- Section II Shuttle Can Do Log
- Cards for Shuttle Can Do
- Payload #6 Map
- Post-test

Space Shuttle Given a Push

WASHINGTON (AP)—President Carter's budget for fiscal 1981 calls for increased spending on the space shuttle, reflecting his commitment to push development of America's manned space program for both commercial and military purposes.

Carter is asking for $1.8 billion for continued shuttle development, up from $1.6 billion in 1980. He also requested a 1980 budget supplement of $200 million for tests to help the space agency overcome technical problems which have delayed the spaceship's maiden launch.

The shuttle funds are included in a proposed 1981 outlay of $5.4 billion for the National Aeronautics and Space Administration, a boost of $400 million over the current fiscal year.

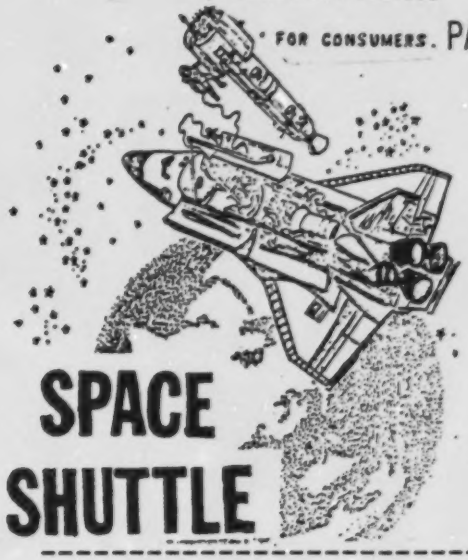
The president declared his full support for the shuttle last Nov. 14 following a White House meeting during which NASA and Defense Department officials explained the craft's problems and explained the role it will play as a space workhorse for the remainder of the century.

A fleet of four or five of the reusable shuttles is planned to carry hundreds of military, scientific, commercial and other payloads into orbit. They also will enable scientists, engineers and researchers from many nations to experiment in space.

The initial flight of the first shuttle, Columbia, originally scheduled in 1979, now is set for next August or September.

The budget also proposes the start of two major new NASA programs in 1981—an orbiting observatory to probe the nature and origin of the universe and a national oceanographic satellite system to provide global weather and ocean data.

January 28, 1980
K. C. Star



PACKAGE RESUME FORM

PUBLICATION DATE: August, 1979

LEVEL/SUBJECT: Science/Social Studies

AUTHOR: Della Butler

TITLE: The Space Shuttle

ABSTRACT:

The United States Space Program has entered a new era with the development of the Space Shuttle. The purpose of this learning capsule is to provide understanding of the Space Shuttle as a new kind of transportation for conveying goods and performing services in space.

This capsule can be a valuable tool in the classroom inasmuch as there is very little student material available on the Space Shuttle. However, this capsule provides much detailed informational reading about the Space Shuttle. (All of which may be taped for the non-reader) Many activities are designed to reinforce the concepts contained in the reading. The activities are designated as "Missions" for the student to do.

The capsule is written in two sections. In Section I, the student will learn the main parts of the shuttle. Section II deals with the uses of the shuttle and how it will be beneficial to consumers on earth.

The study of the shuttle lends itself well to a learning center, especially for those students who have a keen interest in the subject of space. This will provide ample material for an in-depth study of the shuttle for those students in particular. It could, of course, be used for the entire class.

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OBJECTIVES

Upon completion of this capsule, your students will be able to:

* explain what a space shuttle is
* name the main parts of the space shuttle
* design a space shuttle
* explain some of the shuttle's uses to consumers
* compare present transportation systems to future transportation needs in space
* explain how a space shuttle can reduce cost compared to other space efforts

SPECIAL INSTRUCTIONS AND SUGGESTIONS

This capsule is designed with a learning center approach in mind. The material could, however, be used for an entire class.

Posters or any pictures which can be found in newspapers or magazines would provide motivation for a Space Shuttle Bulletin Board. Allow space for the student to display drawings he/she may make.

Posters may be obtained by writing:

Center for Aerospace Education Development
Civil Air Patrol National Headquarters
Maxwell AFB, AL 36112

The Teacher's Guide contains contains drawings of the shuttle which may be reproduced as well as all worksheets the student will need.

Before starting the capsule, the teacher should duplicate the following materials and have them available at the center for the student:

For Section I you will need to duplicate:

Orbiter blank
Manipulator Arms blank
Record Sheet

For Section II you will need to duplicate:

U. S. Map

DIRECTIONS FOR MAKING THE CONTAINER FOR THIS CAPSULE

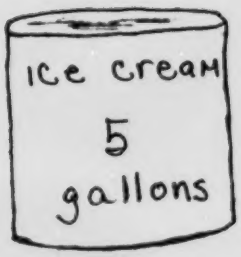
(optional)

Cover an empty 5 gallon ice cream container with suitable paper.

Add cardboard sides to resemble a space shuttle.

For a lid, shape tagboard into a cone. Staple and cover also.

1



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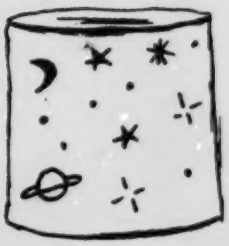
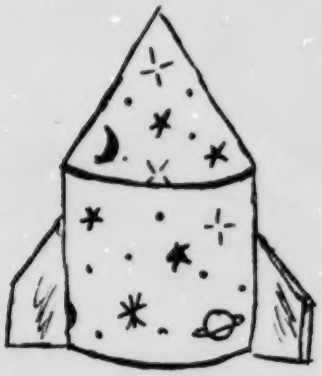


3.

4.

5.

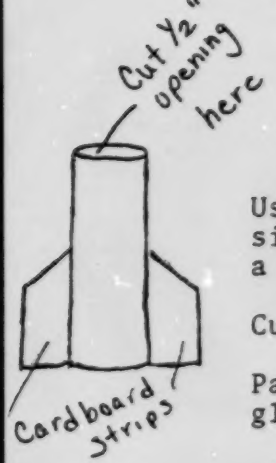


COMPLETED CONTAINER

MATERIALS LIST FOR SPACE SHUTTLE CAPSULE

SECTION I

MISSION #1	Pre-Test & pencil
MISSION #2	None
MISSION #3	Orbiter blank worksheet to be labeled & pencil
MISSION #4	Manipulator Arms worksheet and pencil
MISSION #5	Notebook paper & pencil
MISSION #6	Article "Moonwalk" by Iaasic Asimov
	Drawing paper
	Well supplied scrap box containing pringle cans and any odds and ends to be used to recycle into a shuttle of the student's own design.



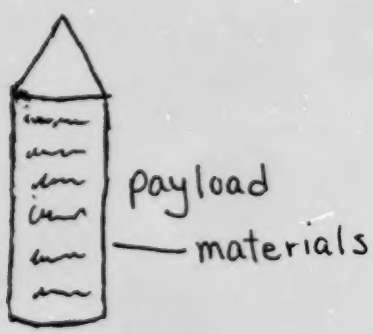
SECTION II

(SHUTTLE CAN DO)

Use pringle can and cover with anything suitable. I used silver contact paper. Add strips of cardboard to resemble a space shuttle.

Cut ½" rectangular opening in lid.

Payload material is printed in the Teacher's Guide. Cut strips, glue on heavy paper and laminate for durability.



ACTIVITIES

page 1 This page may be read to the student beginning this capsule.

page 2 Ask student to read this page carefully as it explains what he/she is expected to do in this capsule.

page 3 This page presents the objectives to the student.

page 4 Mission #1 The pre-test is included in the Teacher's Guide. See appendix.

page 4 Mission #2 Teacher may want to have student or class read the Introduction (pp. 5-6) and poem (p.7) together and discuss. If posters are on display they may be used to stimulate discussion.

page 8-10 Mission #3 These pages are information pages directed toward the student.

Page 11-13 Mission #4 The student will find a detailed diagram of the Cargo Bay. He/she must read the information and make careful observations. A student worksheet is provided for the Manipulator Arms activity. See appendix.

page 14-16 Mission #5 A reading page for the student plus diagrams to study. Student may use notebook paper to do "Get a Boost Out of These".

page 17 The recycling idea is to be brought out and discussed for ideas that individuals or groups may do.

page 18-26 Mission #6 These are reading and study pages for the student. The article "Moonwalk and Beyond" is provided for the student along with an article about the author, Isaac Asimov. The teacher may want to provide scrap materials for recycling projects. Art paper should also be provided for the drawing activity.

ACTIVITIES (Cont.)

Section II Shuttle Can Do

Copies of the payload task cards are provided following this page. These cards should be cut and mounted on tagboard. Laminating will help to protect them. They will fit into a "recycled" potato chip can made to look like a shuttle. See page 6 of this guide for directions on construction of Shuttle Can Do.

The Space Shuttle

Pre-test

Name Key Date _____

Circle the letter of the correct answer.

1. How many main parts does a Space Shuttle have?
   a. 5
   b. 10
   (c.) 3
   d. 4

2. The Space Shuttle
   a. can carry four or five scientists.
   b. is a space lab.
   c. will cost too much money to be of use to consumers.
   (d.) can be used to carry goods and services in space.

3. The orbiter will land
   (a.) on a runway.
   b. in the ocean.
   c. on a lake.
   d. by parachute.

4. The solid rocket boosters will be
   a. used only once.
   (b.) reused.
   c. remain attached.
   d. burned up.

5. How many days will the average space shuttle mission last?

   a. one to three days

   b. three to six days

   (c.) seven to thirty days

   d. longer than thirty days

6. The orbiter will differ from any other American manned spacecraft in that it will be

   a. smaller.

   (b.) reusable.

   c. expensive.

   d. rocket powered.

7. Which of the following types of missions will be accomplished by the space shuttle?

   a. carry Spacelab

   b. build colonies in orbit around the earth

   c. locate new energy sources

   (d.) all of the above

8. To "recycle" means to

   a. put into orbit.

   (b.) reuse.

   c. land.

   d. burn up.

9. Fuel burned in the external fuel tank will be

   a. gasoline.

   b. diesel.

   (c.) liquid hydrogen and liquid hydrogen.

   d. hydrogen and oxygen.

10. The space shuttle will be the most important spacecraft ever launched by the United States because

a. it is less expensive than other satellites.

b. it will carry foreign personnel into space.

(c.) it will provide many benefits to consumers.

d. it will be reusable.

The Space Shuttle

Post-test

Name Key Date _____

Circle the letter of the correct answer.

1. A space shuttle has three main parts. They are
   a. manipulator arms, cargo bay and orbiter.
   (b.) the orbiter, solid rocket boosters and external fuel tank.
   c. external fuel tank, solid rocket boosters and cargo bay.
   d. cargo bay, orbiter, solid rocket boosters.

2. Which tasks can the orbiter perform?
   a. serve as a delivery truck in space
   b. serve as a living place for the crew
   c. serve as a mechanism to build in space
   (d.) all of the above

3. The cargo bay is used
   (a.) to carry goods.
   b. for transporting scientists.
   c. to store extra fuel.
   d. to dispose of waste materials from earth.

4. The orbiter will land
   a. in the ocean.
   b. on a launching pad.
   (c.) on a runway.
   d. by parachute.

Space Shuttle Post-test (Cont.)

5. The solid rocket boosters will be
   a. reused.
   b. used only once.
   c. stay in orbit.
   d. burned up.

6. The orbiter is different from any other manned spacecraft the U.S. has had because it is
   a. larger.
   b. more expensive.
   c. rocket powered.
   d. reusable.

7. The space shuttle can accomplish which of the following missions?
   a. locate new energy sources
   b. build factories in space
   c. carry spacelab
   d. all of the above

8. The kind of fuel burned in the external fuel tank will be
   a. propane.
   b. liquid hydrogen and liquid oxygen.
   c. gasahol.
   d. butane and propane.

9. The space shuttle will be the most important spacecraft launched by our country because
   a. it is bigger than other satellites.
   b. it will provide many benefits to consumers.
   c. it will be reusable.
   d. it is less expensive.

Space Shuttle Post-test (Cont.)

10. Which of the following is <u>not</u> a way that the space shuttle will help consumers?
    a. place satellites in orbit that will speed communications between continents
    b. support exploration for oil, gas and mineral deposits
    (c.) carry astronauts to the moon
    d. help solve the world's food problems by identifying plant diseases.

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"Enterprise: Taxicab to Space", The Rotarian, June 1978--Eds.

Space Shuttle, Space Civil Air Patrol, Maxwell Air Force Base, Alabama.

FILM

"Space Shuttle", 16mm, color, sound, 15 min NASA Film Library, Washington, DC. 20409.

APPENDIX

This appendix contains copies of all worksheets and assessments. These copies may be used to make your own classroom quantity copies. To use, unstaple the sides of the teacher's guide and remove the worksheet and assessment pages. Restaple the remaining pages of the teacher's guide.

The Space Shuttle

Pre-test

Name _____ Date _____

Circle the letter of the correct answer.

1. How many main parts does a Space Shuttle have?
   a. 5
   b. 10
   c. 3
   d. 4

2. The Space Shuttle
   a. can carry four or five scientists.
   b. is a space lab.
   c. will cost too much money to be of use to consumers.
   d. can be used to carry goods and services in space.

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   b. in the ocean.
   c. on a lake.
   d. by parachute.

4. The solid rocket boosters will be
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   b. reused.
   c. remain attached.
   d. burned up.

5. How many days will the average space shuttle mission last?
   a. one to three days
   b. three to six days
   c. seven to thirty days
   d. longer than thirty days

6. The orbiter will differ from any other American manned spacecraft in that it will be
   a. smaller.
   b. reusable.
   c. expensive.
   d. rocket powered.

7. Which of the following types of missions will be accomplished by the space shuttle?
   a. carry Spacelab
   b. build colonies in orbit around the earth
   c. locate new energy sources
   d. all of the above

8. To "recycle" means to
   a. put into orbit.
   b. reuse.
   c. land.
   d. burn up.

9. Fuel burned in the external fuel tank will be
   a. gasoline.
   b. diesel.
   c. liquid hydrogen and liquid hydrogen.
   d. hydrogen and oxygen.

10. The space shuttle will be the most important spacecraft ever launched by the United States because

    a. it is less expensive than other satellites.

    b. it will carry foreign personnel into space.

    c. it will provide many benefits to consumers.

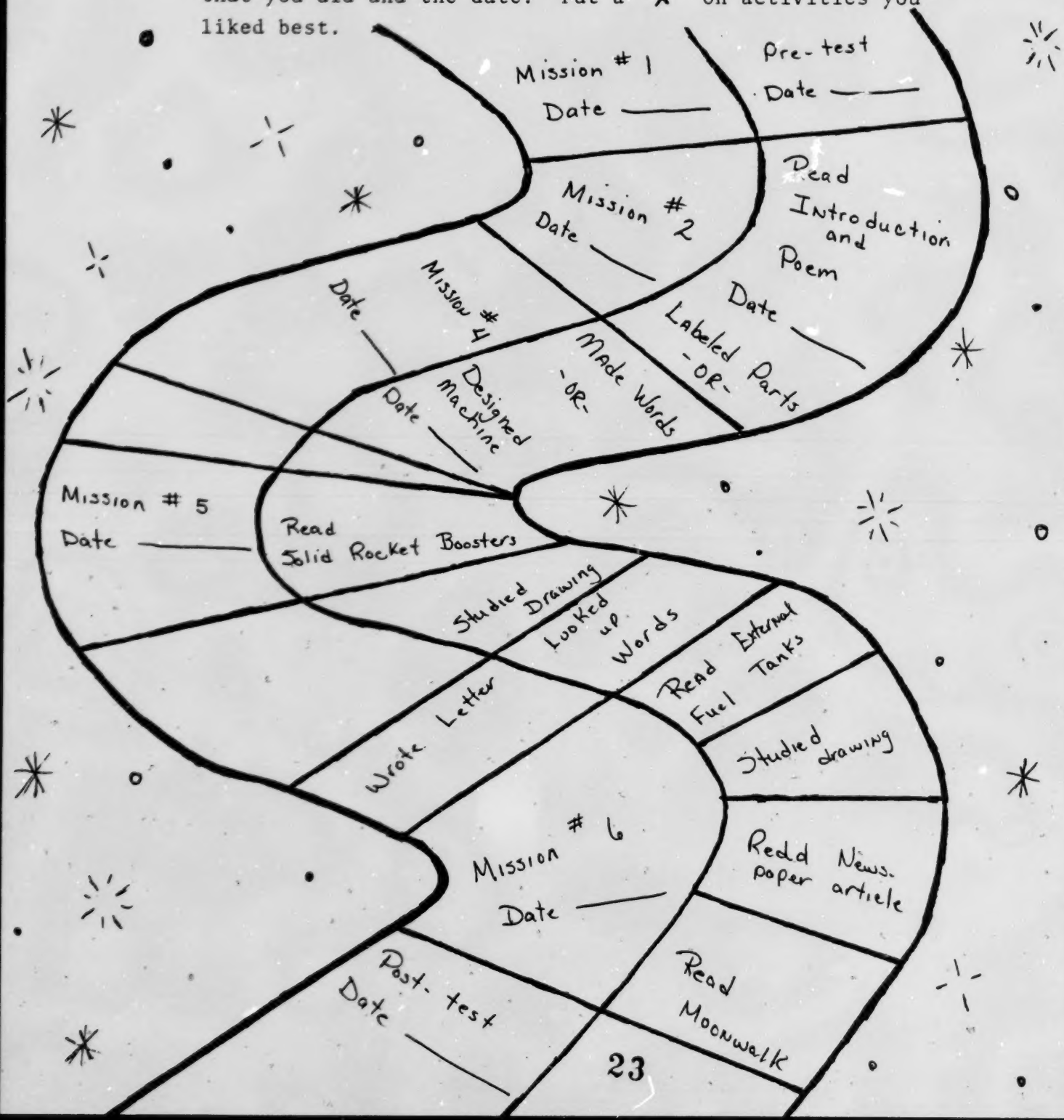
    d. it will be reusable.

. SPACE SHUTTLE
RECORD SHEET

SECTION I
"STUDENT SPACE LOG"

NAME _____ DATE _____

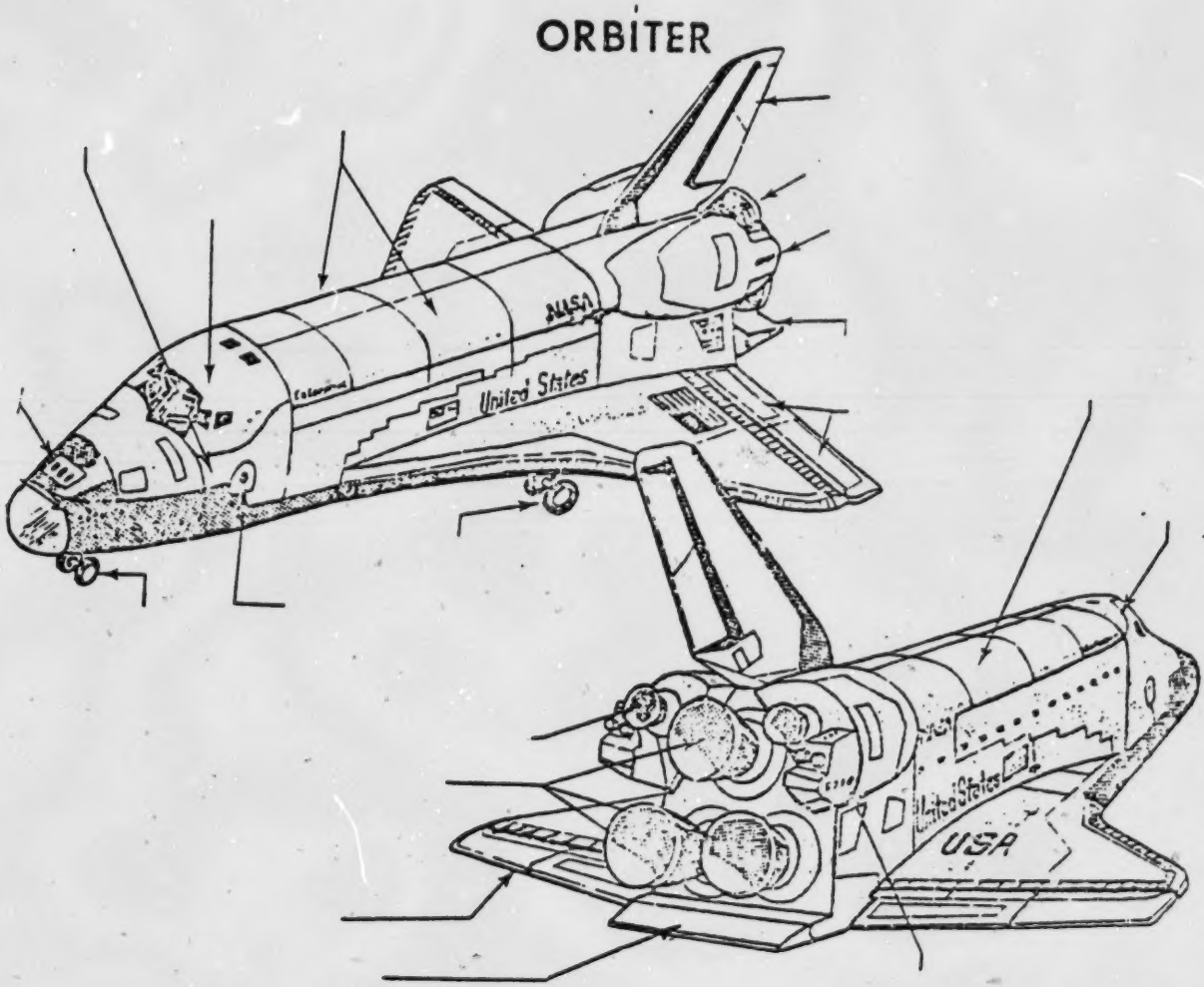
After you complete each Mission, put an "X" on each activity that you did and the date. Put a ★ on activities you liked best.



Name _____ Date _____

Mission #3

Label the parts of the orbiter.



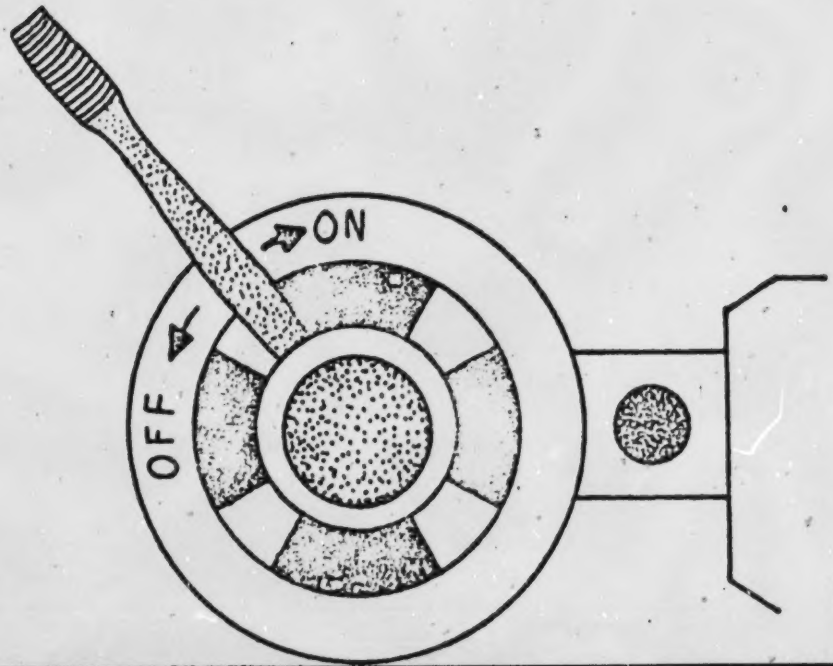
Mission #4 Manipulator Arms

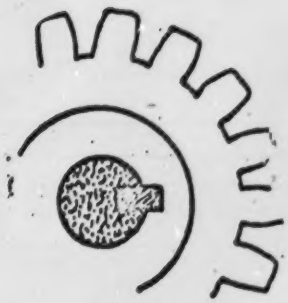
Name _____ Date _____

How many words can you think of using the letters of M A N I P U L A T O R A R M S? Write your words on this paper.

OR

Connect the gears and levers below to dream a machine of your own.



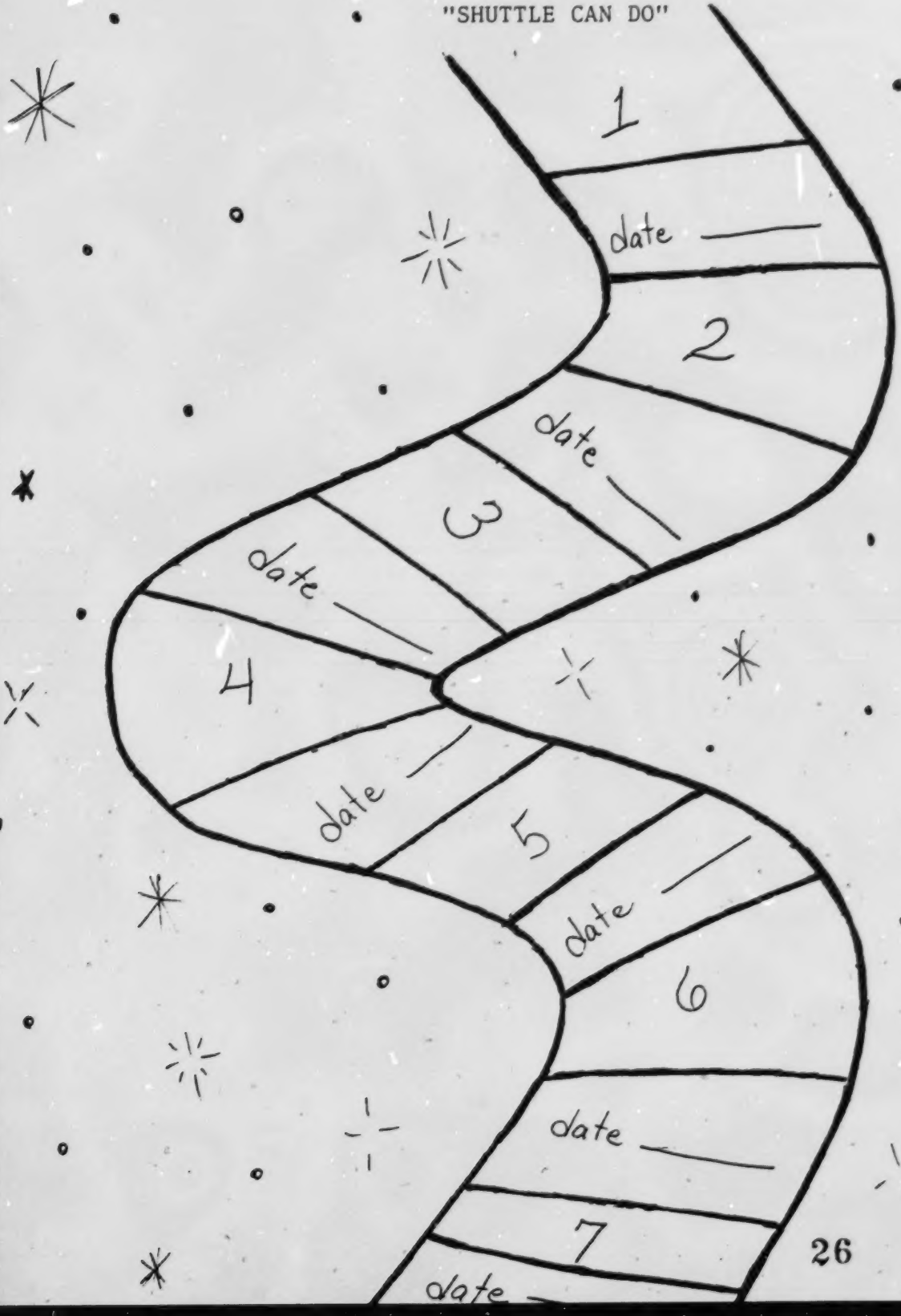


SPACE SHUTTLE--Record Sheet

NAME _____ DATE _____

SECTION II

"SHUTTLE CAN DO"



4

It is July 1980, and the Shuttle has been launched successfully and is now in orbit. In addition to the crew, there are three marine scientists aboard. They will be mapping the surface of oceans and observing current patterns. The Orbiter will be conducting a combined satellite and emplacement mission. In it's cargo bay is a High Energy Astronomy Observatory (HEOA), which will be placed in orbit and after servicing of the Earth Observations Satellite (EOS) is completed.

Write a front page story for the newspaper about the successful launch of the Shuttle and it's three-fold mission.

You may want to include the public's reaction to this scientific achievement. Use photos or sketches, captions, and a headline that would capture a reader's interest. Remember a successful article takes careful planning and research of your subject.

PLACE YOUR ARTICLE ON THE SPACE BULLETIN BOARD.

3

With each advance in civilization and each stride toward a higher standard of living, man has used more and more irreplaceable resources. He has scarred the earth's surface with strip mines, burned and cut the forests and polluted the air and water. He has littered the face of the earth with empty can, broken bottles, garbage dumps and desolate battlefields.

Only recently has man realized that he must stop waste, recycle and reuse many materials and conserve his natural resources. The Space Shuttle will be an important tool in the management and preservation of the earth's resources.

LIST FIVE THINGS THAT YOU KNOW OF WHICH CAN BE RECYCLED.

HOW DOES RECYCLING HELP YOU AS A CONSUMER?

SHOULD LAWS BE ENACTED TO PUNISH THOSE WHO CONTINUE TO WASTE OUR NATURAL RESOURCES? WHY OR WHY NOT?

2

The Space Shuttle will perform many jobs and serve many uses. It will place satellites into orbit that will:

1) speed communications between continents.

2) perform environmental studies and watch for pollution.

3) support exploration for oil, gas and mineral deposits.

4) aid forest conservation by early fire detection.

5) assist oceanographers in the study of ocean current patterns.

6) take completely equipped scientific laboratories into earth orbit.

7) help solve the world's food problem by identifying plant diseases and insect damage.

SELECT THE SHUTTLE TASK YOU FEEL IS MOST IMPORTANT. READ ABOUT IT IN SCIENCE BOOKS, ENCYCLOPEDIAS OR IN LITERATURE ABOUT THE U.S. SPACE PROGRAM. MAKE A LIST OF TEN FACTS YOU DISCOVERED ABOUT YOUR SUBJECT.

WRITE WHY YOU FEEL IT IS THE SHUTTLE"S MOST IMPORTANT TASK TO YOU AS THE CONSUMER.

1

The Orbiter's large cargo bay can accomodate a fully equipped laboratory. It can be used for many types of observations and experiments. It can also be used to develop new manufacturing techniques and processes in the absence of earth's gravity.

PLAN A FACTORY TO BE BUILT IN SPACE.

You may either sketch your factory,

OR

you may write about your factory.

7

The Space Shuttle will become operational in 1980 and will provide mankind with important information to aid in the management and preservation of our earth.

WRITE A LETTER TO:

Nat'l. Aeronautics and Space Administration, Washington, D. C.

Ask for information about the Space Shuttle and the services it will perform that will benefit consumers. (If you do not remember the proper format for writing a letter, refer to your language book.)

SHOW THE LETTER THAT YOU HAVE WRITTEN TO YOUR TEACHER.

6

Many companies throughout the U.S. are developing parts for the Space Shuttle. Some of these companies are located in the following cities and states. Use an Atlas to find these cities.

ON A U.S. MAP PLACE A STAR AT THE CORRECT POSITION FOR EACH OF THE FOLLOWING:
(A blank map is provided for you at the Shuttle Center.)

Downey, California
(Rockwell)

Arlington, Virginia
(Bendix)

Skokie, Illinois
(Brunswick)

Melbourne, Florida
(Harris)

St. Louis, Missouri
(McDonnel-Douglas)

Brigham City, Utah
(Thiokol)

Michoud, Louisana
(Martin-Marietta)

Huntsville, Alabama
(IBM-NASA)

Bethpage, New York
(Grumman)

Palmadale, California
(Rockwell)

5

The care taken with food for the astronauts has led to new and improved methods of processing, sterilizing and preserving food. Food additives and nutritional quality are areas of concern for the food industries of the world. The food supply for astronauts must be free from bacteria, high in nutritional value, easily prepared and able to be stored without refrigeration.

Using these same methods, certain foods can be stored for emergency or disaster situations on earth. Some forms of these foods are on your grocer's shelves. So you, as a consumer of these foods have benefitted from the work scientists have done for astronauts.

1. Name some foods that have been used by the astronauts which you can buy at your store.

2. Are these foods pleasant to taste?

Payload Task Card #6 Map

United States of America

The Space Shuttle

Post-test

Name _____ Date _____

Circle the letter of the correct answer.

1. A space shuttle has three main parts. They are
   a. manipulator arms, cargo bay and orbiter.
   b. the orbiter, solid rocket boosters and external fuel tank.
   c. external fuel tank, solid rocket boosters and cargo bay.
   d. cargo bay, orbiter, solid rocket boosters.

2. Which tasks can the orbiter perform?
   a. serve as a delivery truck in space
   b. serve as a living place for the crew
   c. serve as a mechanism to build in space
   d. all of the above

3. The cargo bay is used
   a. to carry goods.
   b. for transporting scientists.
   c. to store extra fuel.
   d. to dispose of waste materials from earth.

4. The orbiter will land
   a. in the ocean.
   b. on a launching pad.
   c. on a runway.
   d. by parachute.

Space Shuttle Post-test (Cont.)

5. The solid rocket boosters will be
   a. reused.
   b. used only once.
   c. stay in orbit.
   d. burned up.

6. The orbiter is different from any other manned spacecraft the U.S. has had because it is
   a. larger.
   b. more expensive.
   c. rocket powered.
   d. reusable.

7. The space shuttle can accomplish which of the following missions?
   a. locate new energy sources
   b. build factories in space
   c. carry spacelab
   d. all of the above

8. The kind of fuel burned in the external fuel tank will be
   a. propane.
   b. liquid hydrogen and liquid oxygen.
   c. gasahol.
   d. butane and propane.

9. The space shuttle will be the most important spacecraft launched by our country because
   a. it is bigger than other satellites.
   b. it will provide many benefits to consumers.
   c. it will be reusable.
   d. it is less expensive.

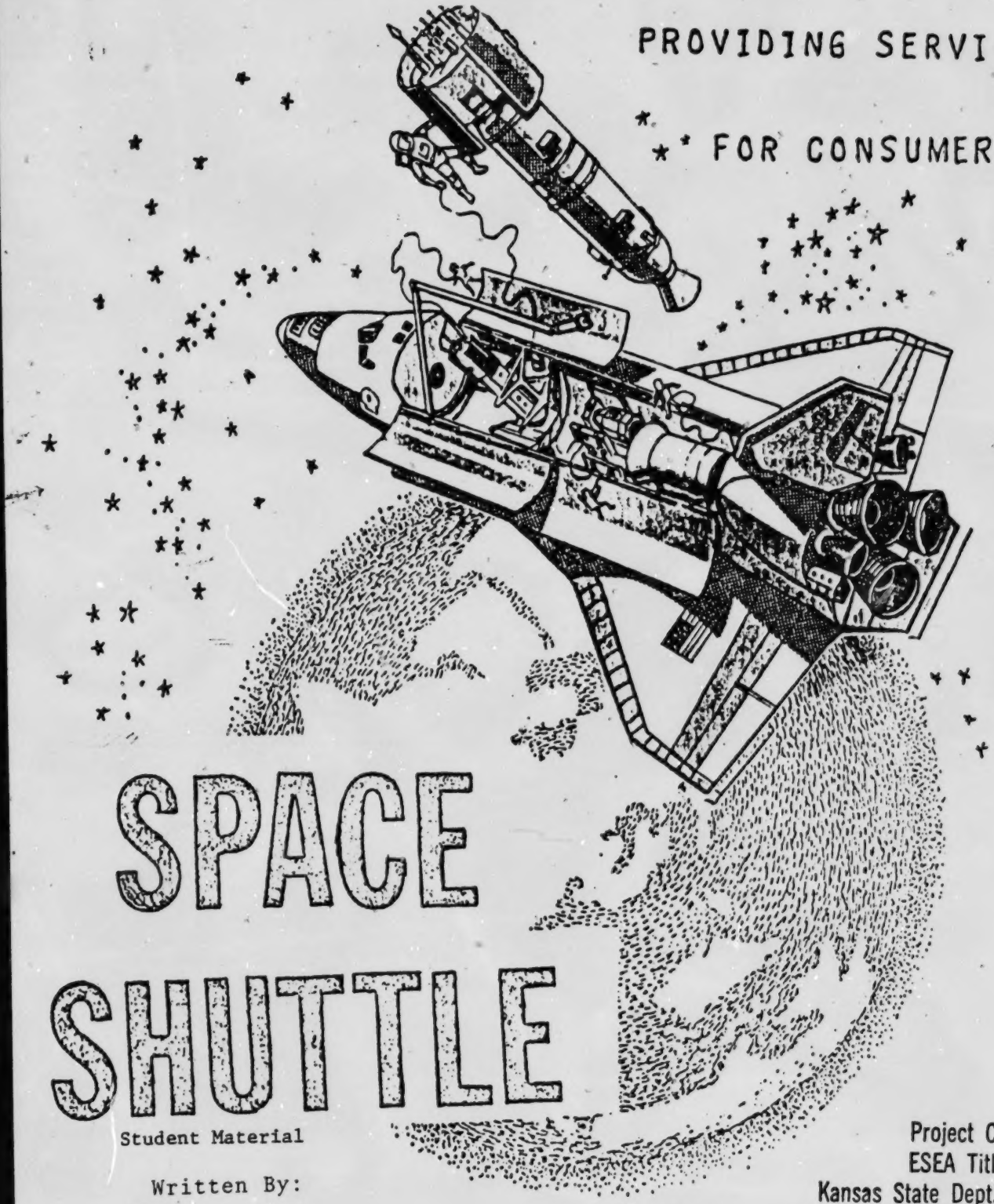
Space Shuttle Post-test (Cont.)

10. Which of the following is not a way that the space shuttle will help consumers?
    a. place satellites in orbit that will speed communications between continents
    b. support exploration for oil, gas and mineral deposits
    c. carry astronauts to the moon
    d. help solve the world's food problems by identifying plant diseases.

A NEW TRANSPORTATION SYSTEM

PROVIDING SERVICE

FOR CONSUMERS.



SPACE SHUTTLE

Student Material

Written By:
Della Butler

Project COST
ESEA Title IV
Kansas State Dept. of Education
USD 449
Easton, KS 66020

C
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For You

To Learn What A Shuttle Can Do

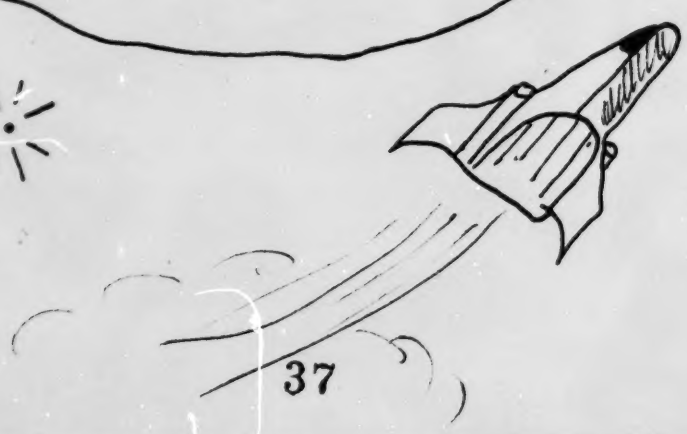
This space learning capsule has two parts.
To learn about shuttles--not carts.
This capsule contains information to be read.
And many activities so all will remain in your head.
But first a pre-flight test you must take.
So your teacher won't think you are a fake.
Don't worry if today there is something you don't know.
Take a trip in this capsule and your learning will show.

DIRECTIONS

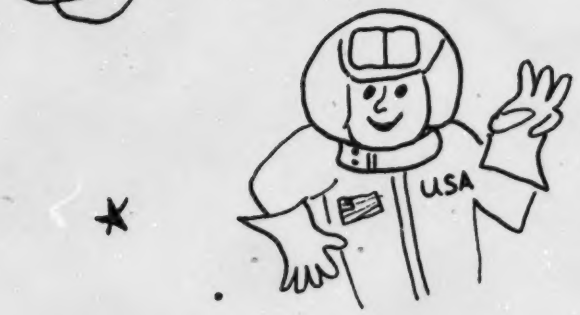
before taking off on Shuttle Study

- Each task for you to do is called Mission. Begin with Mission #1.
- Printed worksheets are provided for you to do your work--called missions.
- Some missions are required. The required missions are marked with a rocket. Sometimes you may choose which activity you would like to do.
- Put your finished work in your folder which is called "Recovery Folder". Some of the work says "display" on the Shuttle Bulletin Board.
- Record each completed mission on your "Space Log" which is also provided for you.

HAPPY SHUTTLING!!



YOU WILL LEARN IN SECTION I:



Things a space shuttle can do to help consumers. It will be used to haul goods and do services in space. Remember, the space shuttle has three main parts. They are:

1. THE ORBITER — Carries the crew and goods to and from orbit.

2. SOLID ROCKET BOOSTERS

3. EXTERNAL FUEL TANK

These two are used to launch the Orbiter

Required

Mission #1

Get the pre-flight test from your teacher. When you have finished, return it to your teacher. RECORD IT ON YOUR SPACE LOG.

YOU ARE NOW READY TO LAUNCH YOUR SHUTTLE STUDY!

READ the Introduction on the next page

****

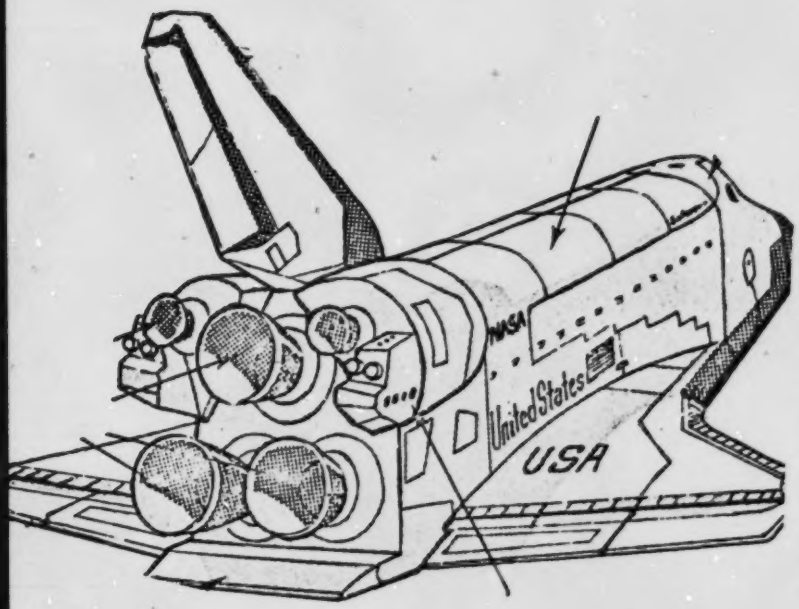
Required

Mission #2

READ the poem "Ode to a Shuttle" following the Introduction. The poem suggests some of the things you will learn in this capsule. . . Its parts and what it can do.

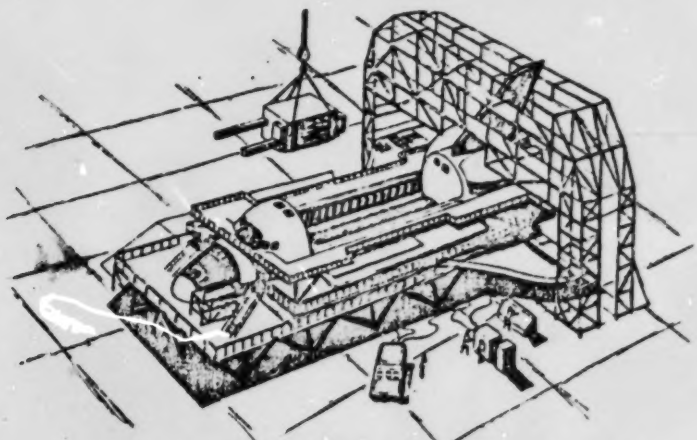
Draw pictures showing 5 uses of the Space Shuttle. RECORD ON YOUR SPACE LOG WHEN YOU ARE FINISHED!

INTRODUCTION



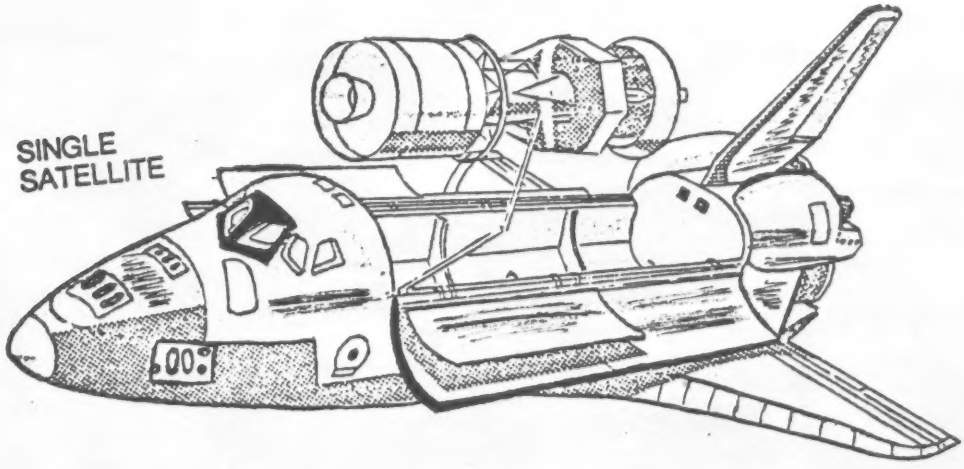
A chubby little aircraft with flashing lights is orbiting the earth. It can stay in space for as long as a month and then fly back to earth and land on a runway like an airplane. This marvelous invention is called a Space Shuttle.

While the Space Shuttle is down on earth it will be readied for another journey into space. In as little as two weeks time the Shuttle should be ready for another trip.



REFURBISHING

One of the Shuttle's primary missions is to deliver satellites into space, repair them if needed, and also return them to earth.



On board it can carry tons of cargo for space missions. The cargo which is carried is called "payload". The Shuttle is going to be used in space to haul goods just as trucks, trains, and ships do now. The Space Shuttle has many uses. It will haul equipment to set up important experiments. It will be used to carry a complete scientific laboratory (Spacelab). The invention of the Space Shuttle will make it possible to build factories and colonies in orbit around the earth. In the future products will be manufactured in space. The Space Shuttle will provide transportation for the factories bringing goods to and from the factories.

The Space Shuttle is always a manned flight which means there is a crew of specially trained persons on board to do the missions.

ODE TO A SHUTTLE

Every lever, every gear
Has a name you must hear.

Some are used many times
To save the U.S. nickels and dimes.

A shuttle can help consumers on earth
By hauling goods with considerable girth.

From a distance high in the sky
It can spot a forest fire burning high.

New sources of energy which the U.S. needs
Could be another of its remarkable deeds.

Checking the farmers' crops for bugs and disease
A shuttle could do with the greatest of ease.

Here and abroad, private and public
Discover now just what makes it tick.

by Della Butler

Mission # 3

THE ORBITER

The Orbiter is a winged spacecraft. It is 122 feet long, 57 feet high, and has a 78 foot wingspan. When it is empty it weighs 150,000 lbs.

The Orbiter carries a crew of four, and sometimes as many as three other passengers who may be scientists.

The cabin has two levels. The crew rides in the front end of the vehicle. The top level, called the flight deck, has all the controls. The lower level has seats for the passengers and sleeping places. It has a kitchen, bathroom, and storage space for equipment.

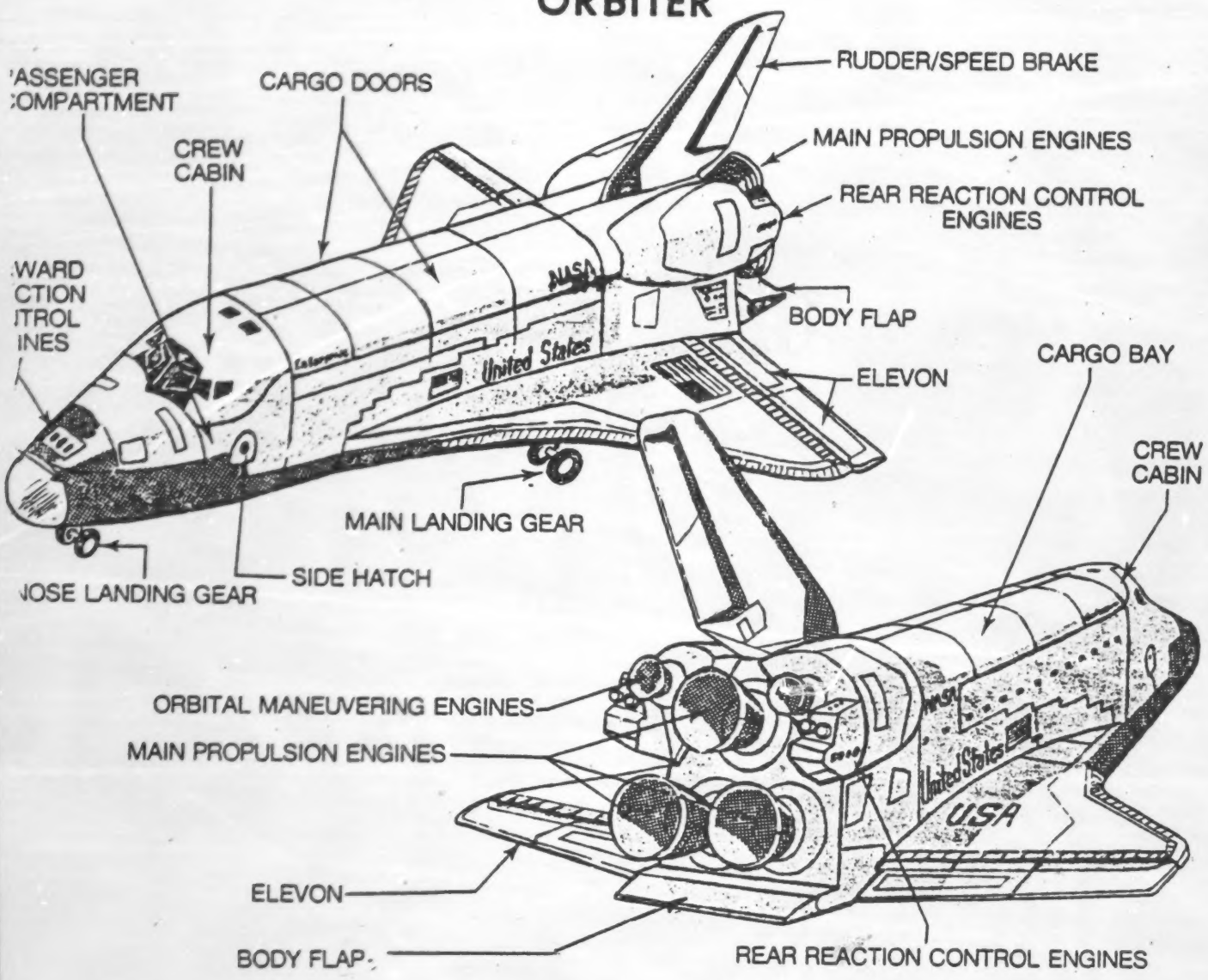
In the mid-section of the Orbiter is the cargo bay. The cargo by is very large--large enough to carry satellites or even a complete laboratory. The cargo bay is 15 feet in diameter and 60 feet long.

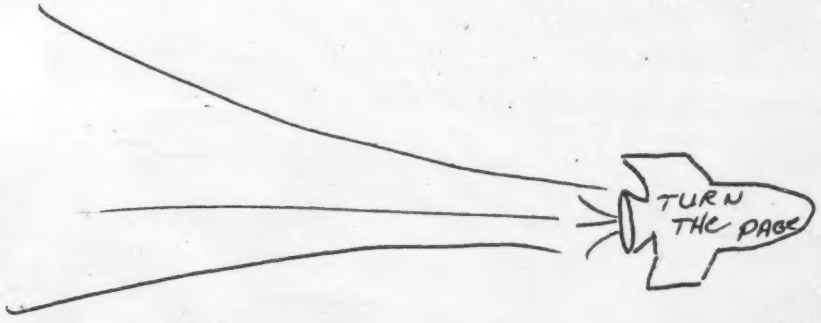
The back end of the Orbiter consists of various liquid fuel rocket engines. The first of these are the three main propulsion engines which are used during launch to carry the Orbiter into space. The fuels for the main propulsion engines are not carried in the Orbiter, but in the External Fuel Tanks underneath the Orbiter.

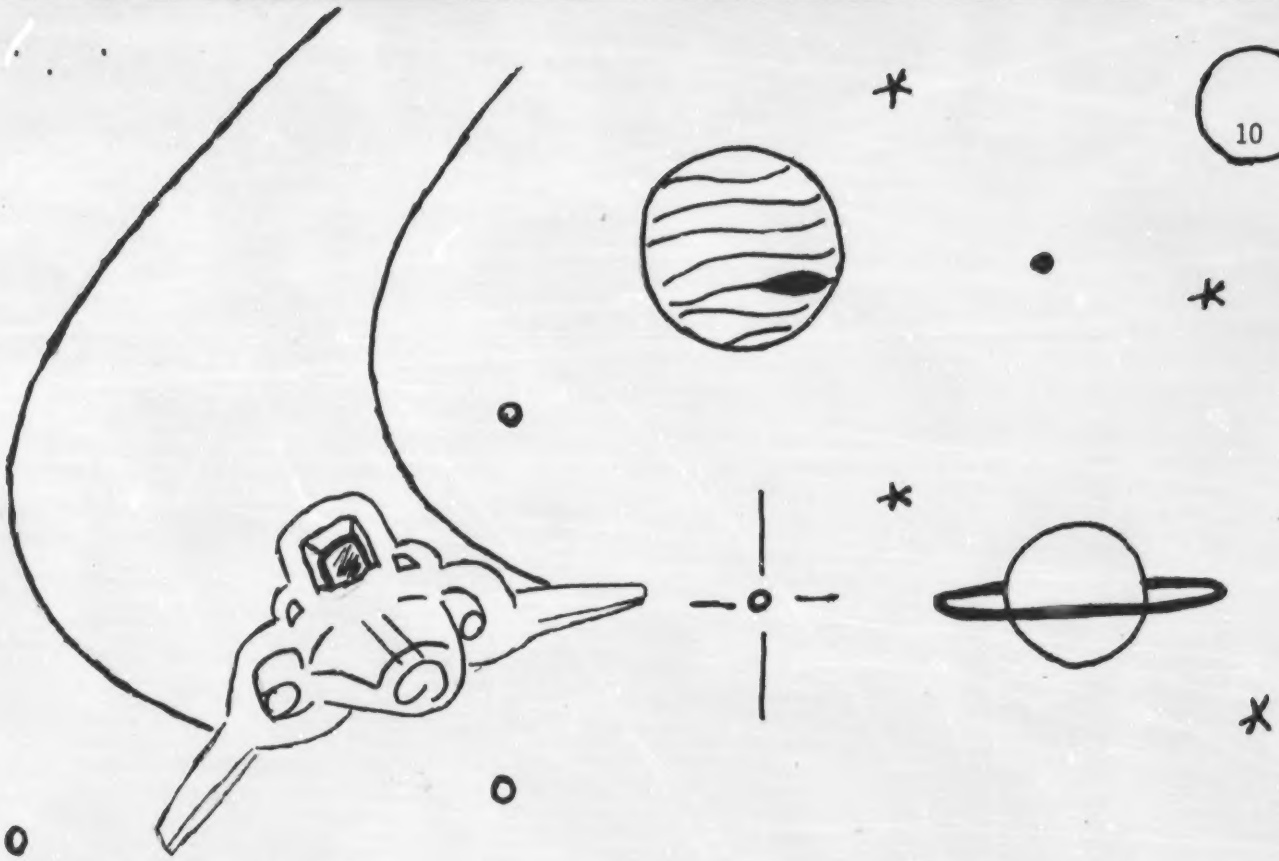
The Orbiter has two engines which are used to place the Orbiter into orbit, maneuver while in space, and to slow down the Orbiter when returning to earth.

REMEMBER!!! YOU ARE STILL ON MISSION #3!!!

ORBITER







end Mission # 3 by :

LABELING THE PARTS OF ORBITER (drawing provided)

or

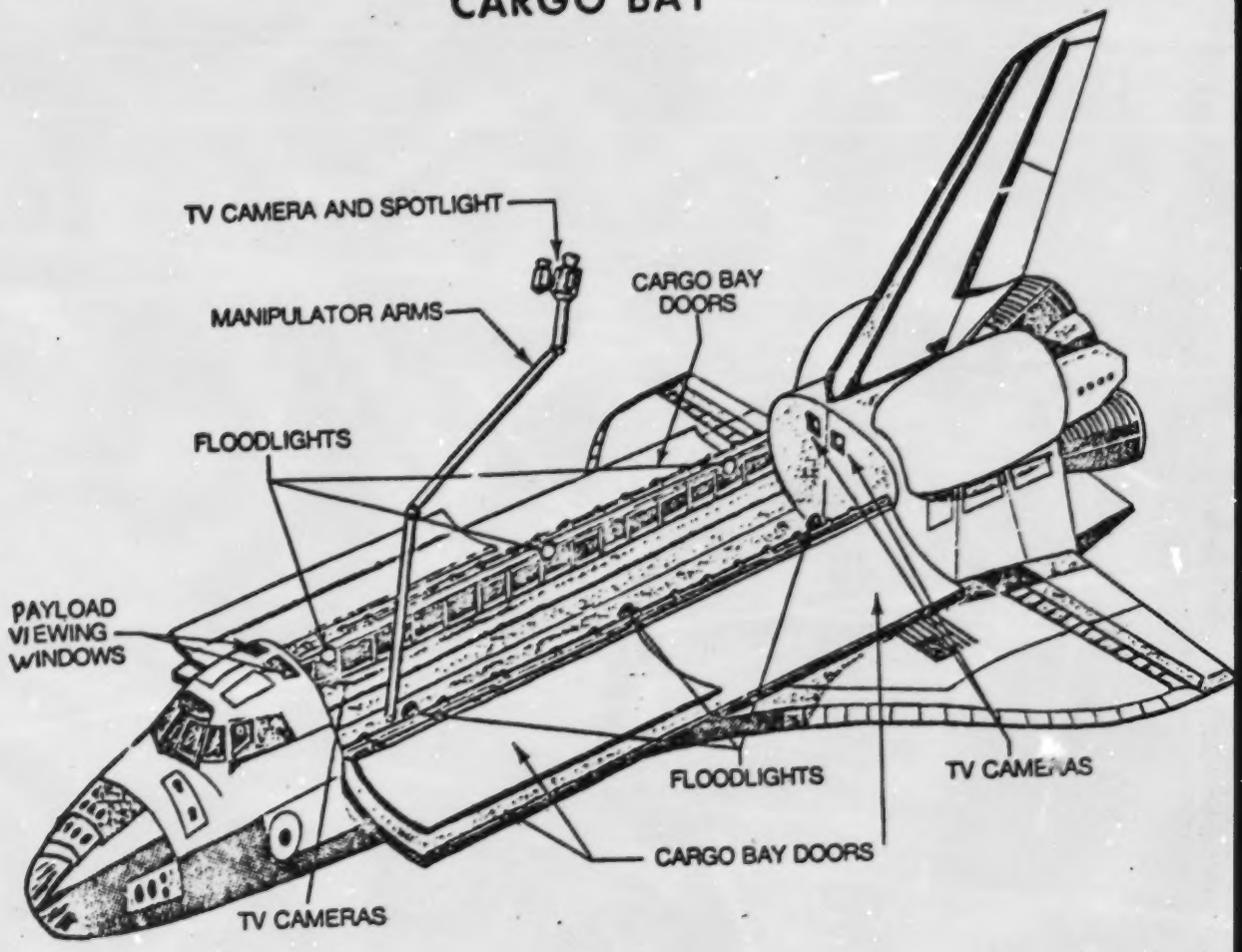
USING THE ORBITER WALL CHART, ASK THE TEACHER TO LET YOU TELL THE CLASS ABOUT THE ORBITER.

If you got carried away with the Orbiter,
look closely at one of its parts--The Cargo Bay

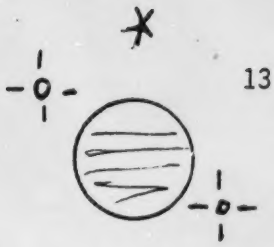
Mission #4

CARGO BAY

12



THE CARGO BAY CAN CARRY ONE OR MORE SATELLITES INTO SPACE OR CAN BE USED TO BRING SATELLITES BACK TO EARTH. THE CARGO BAY IS 15 FEET IN DIAMETER AND 60 FEET LONG AND THE ORBITER CAN CARRY UP TO 65,000 POUNDS INTO ORBIT. THIS IS THE PART OF THE SHUTTLE WHERE GOODS WILL BE PUT AS THEY ARE TRANSPORTED FOR CONSUMER USE IN SPACE.



HOW MANY WORDS CAN YOU MAKE FROM

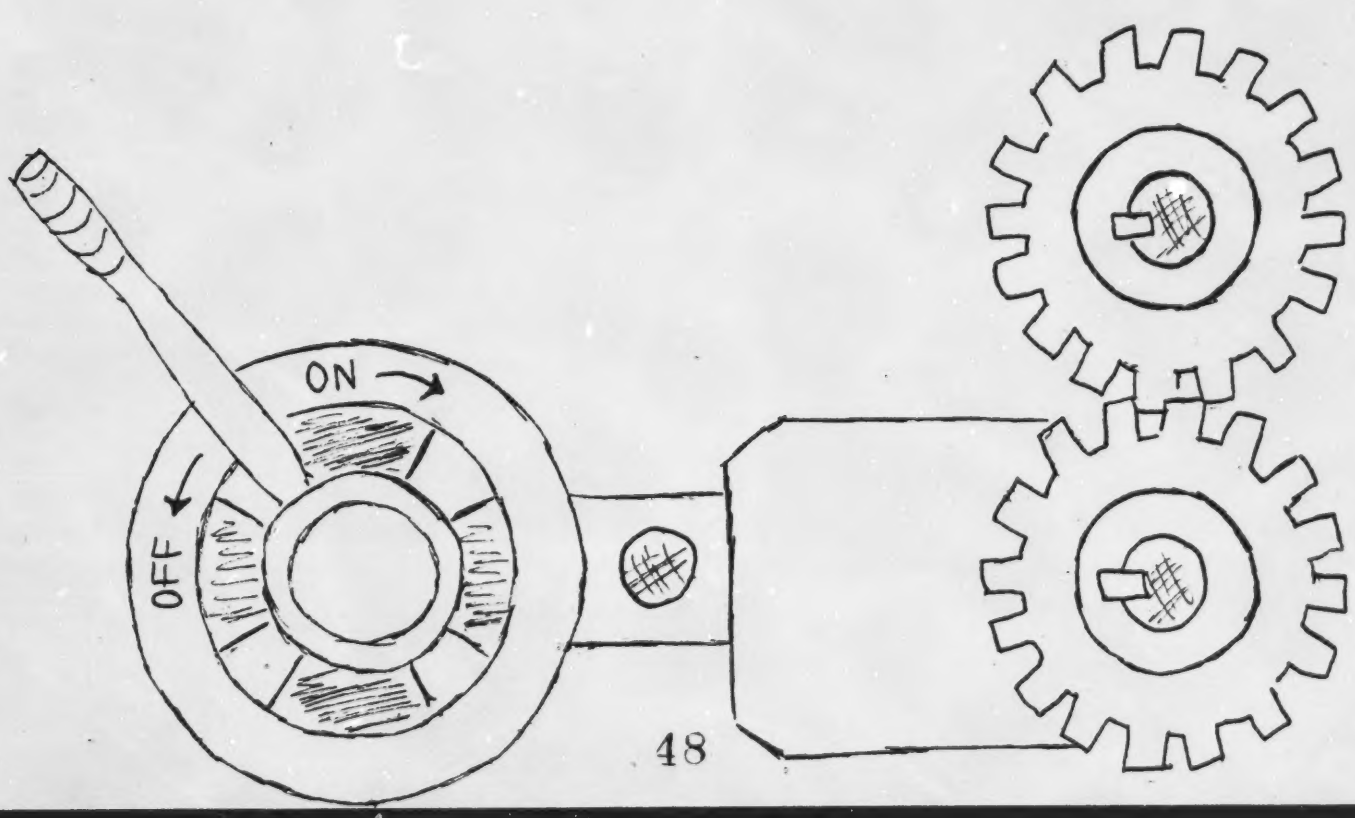
"manipulator arms"?

To complete Mission #4, of course you
will want to do more.
Get the worksheet that is the same as this.
At least twenty words you should not miss.

OR

Connect with lines the gears and the lever
'Til you've invented a machine that is clever.

WHEN YOU FINISH MISSION #4, PUT IT IN YOUR FOLDER & RECORD
IT ON YOUR SHEET



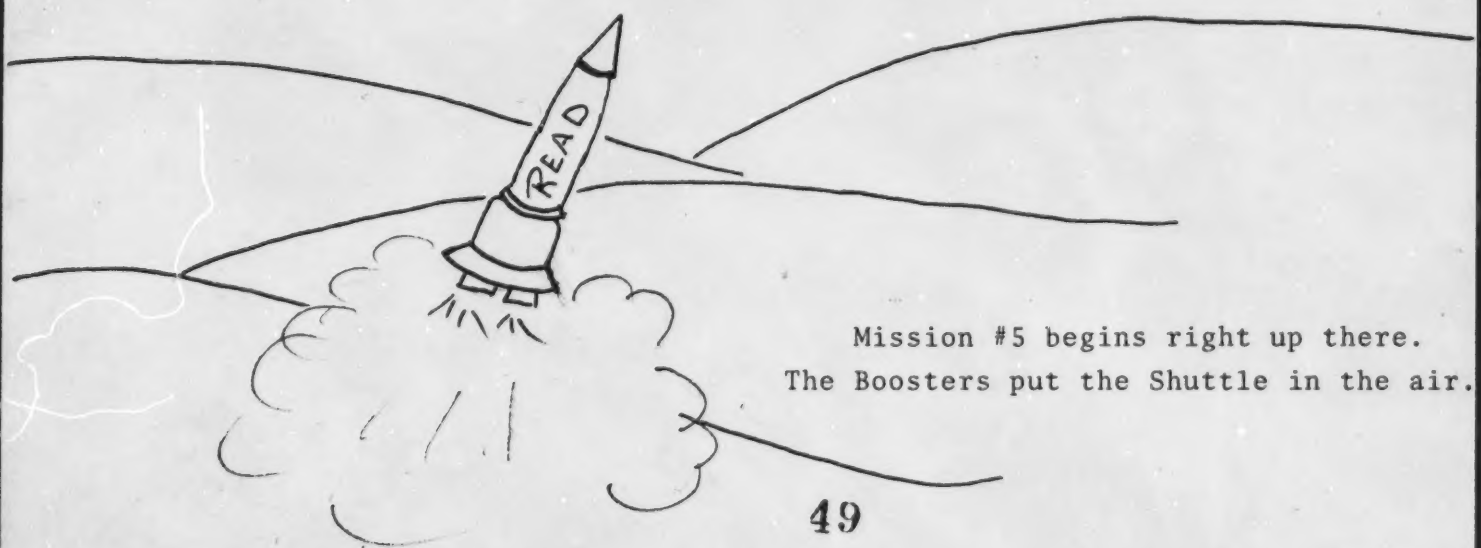
Mission #5

SOLID ROCKET BOOSTERS

In order to launch the Shuttle into space, there are two large solid fuel rockets attached to the External Fuel Tank. (Look at the drawing on the next page.)

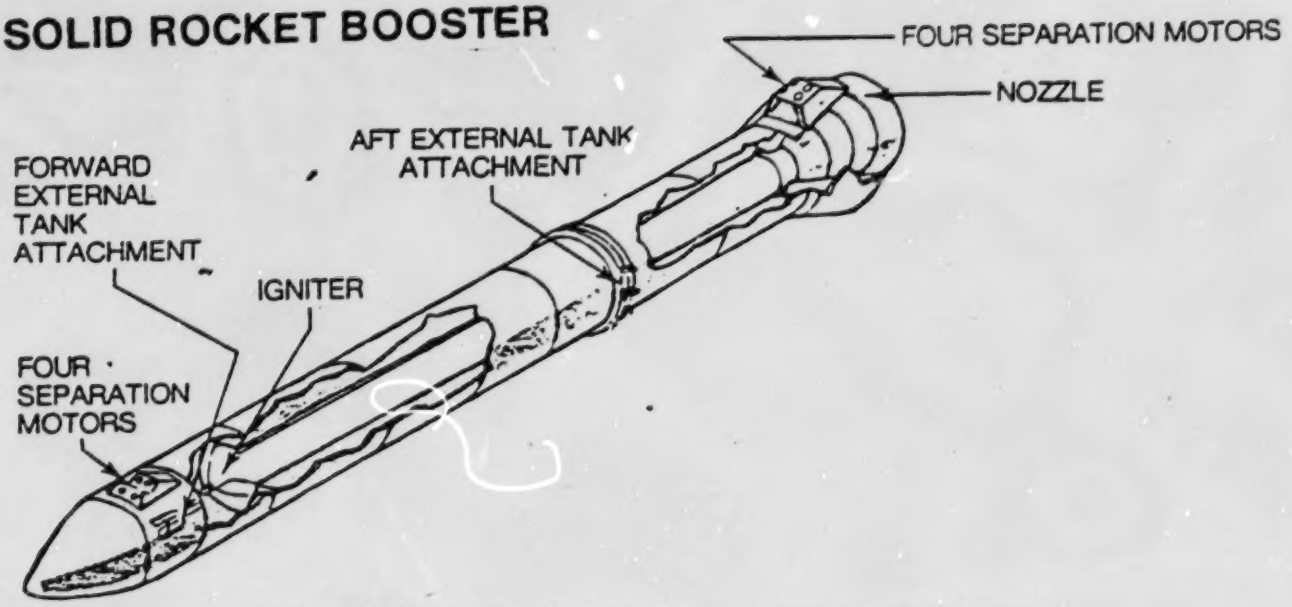
When the Solid Rocket Boosters have reached an altitude of about 27 miles, the Solid Rocket Boosters are jettisoned and parachuted into the ocean. They will be recovered and reused. Using them again is less expensive than having to manufacture new ones for each flight. This reuse then helps to reduce the cost of Shuttle operations to consumers.

Each Solid Rocket Booster is 145 inches in diameter (that's 12 feet plus 1 inch) and 1,790 inches long. They are very heavy. Each one weighs 1,293,004 pounds and produces 2,600,000 pounds of thrust.



Mission #5 begins right up there.
The Boosters put the Shuttle in the air.

SOLID ROCKET BOOSTER

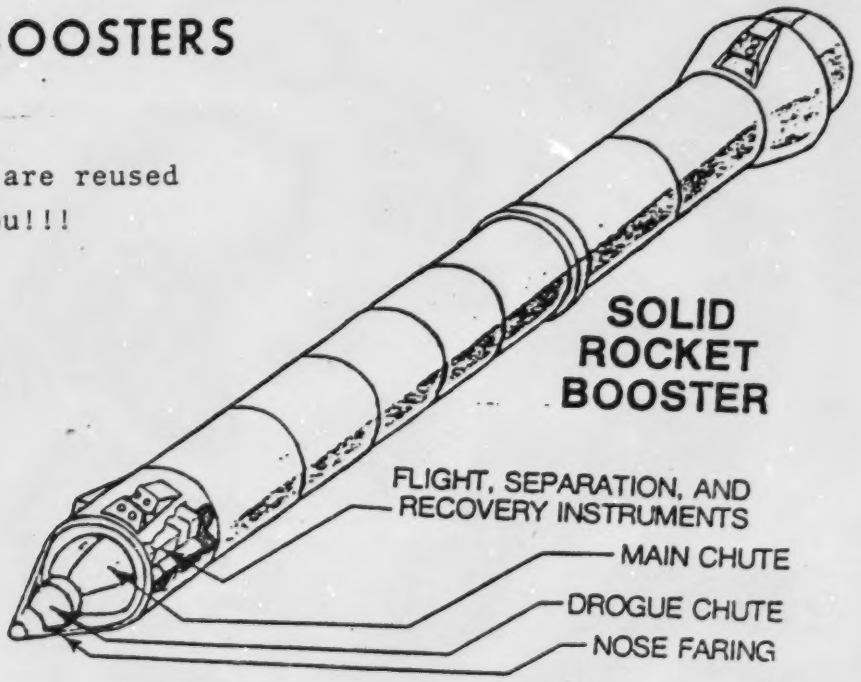


THESE DRAWINGS OF BOOSTERS WILL HELP YOU ARRIVE

KEEP ON LEARNING HERE IN MISSION #5!!!

SOLID ROCKET BOOSTERS

Remember, these are reused
saving money for you!!!



Mission #5

Look up these words. Write their meaning on notebook paper. When you have learned how to spell them and what they mean, have a friend check you.

payload

altitude

jettison

oxygen

orbit

launch

specialist

satellite

reentry

booster

retro-rockets

recycle

cargo

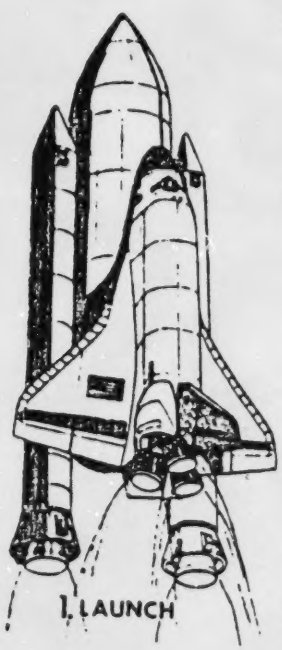
goods

services

consumer

Get a boost

out of these!!!



You have read that the Solid Rocket Boosters will be recovered and used again. This is called recycling. Recycling will save on space travel costs. Some communities have groups or clubs who collect items to be recycled.

Ask your teacher if the class could discuss what your community does to recycle items. Be sure to mention some of the goods which are collected and how they are reused. What can you do to help recycle?

Use your Language Book and write a letter to:

Government Bk. Store No. 15
U. S. Government Printing Office
P. O. Box 713
Pueblo, Colo. 81002

Ask for recycling writing paper, paper towels, construction paper, and typing paper.

OR

Organize a study group on paper recycling and suggest specific action that might be taken in your school system.

Pass the word about recycling to your parents.

Recycling: Saving Money!!

Mission #6

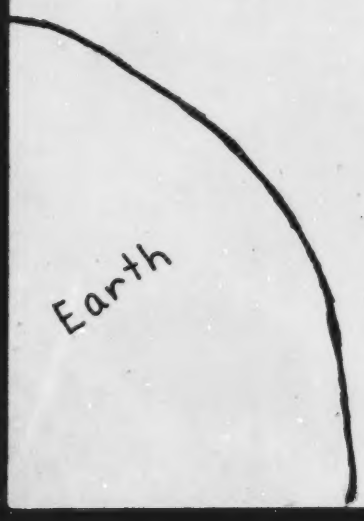
EXTERNAL FUEL TANKS

The External Fuel Tank is 27½ feet in diameter and 154.2 feet long. The tank contains the liquid hydrogen fuel and liquid oxygen which are burned in the Orbiter's three main propulsion engines.

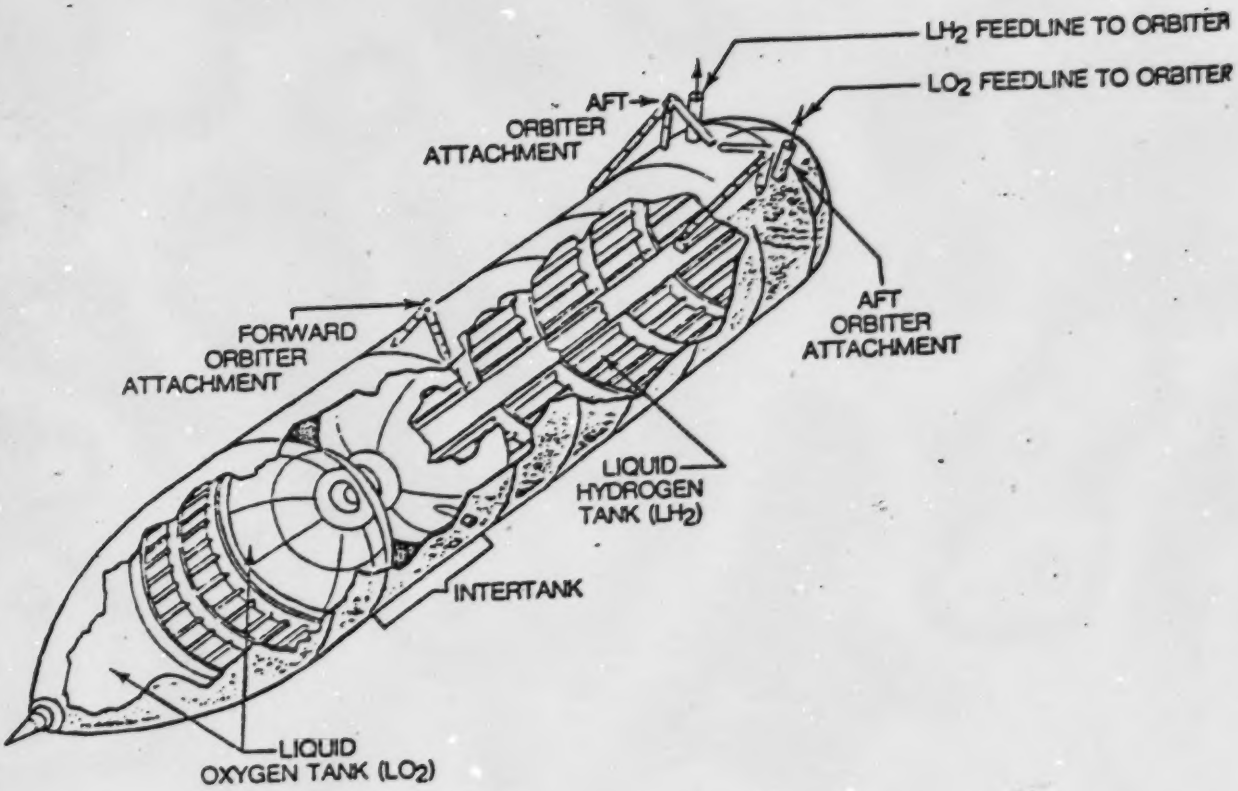
The main propulsion engines burn for about eight minutes using up the 1,556,000 pounds of usable propellants in the External Fuel Tank.

When the Shuttle has reached an altitude of about 70 miles and is traveling at a speed of over 17,500 miles per hour, the External Fuel Tank is jettisoned or thrown off. It will fall into the ocean.

The External Fuel Tank is the only part of the Shuttle system which is not recovered for reuse.



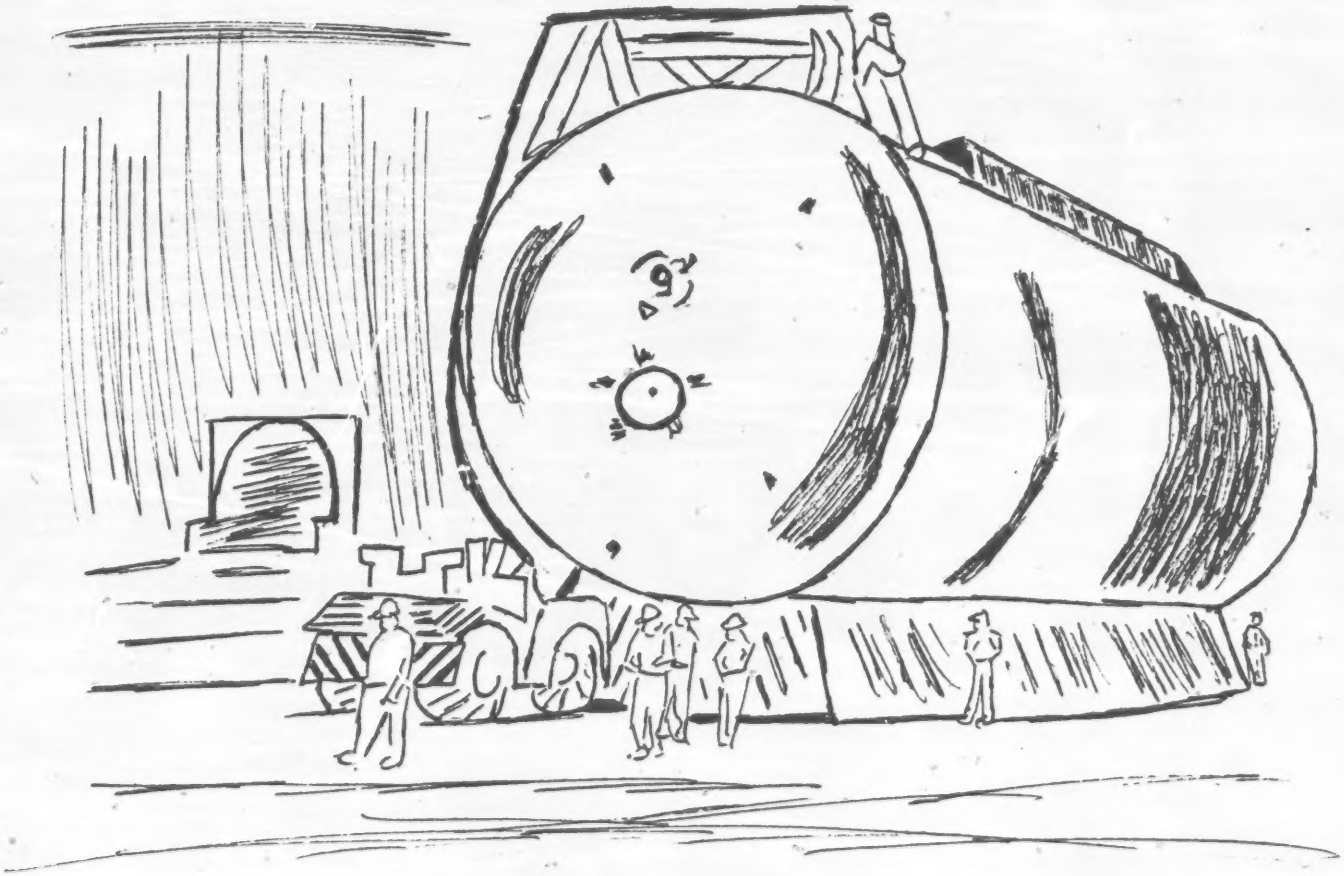
EXTERNAL TANK



WHILE YOU ARE ON MISSION #6--

NOTICE THE TANK THIS DRAWING DEPICTS.

NUMBERS TELLING SIZE DON'T MEAN A GREAT DEAL--
BUT THIS PICTURE IS A COPY OF AN A REAL SHUTTLE
TANK. NOTICE HOW SMALL THE MEN LOOK IN COMPARISON
TO THE SIZE OF THE SHUTTLE TANK.



SHUTTLE TANK--

This is an external fuel tank designed for a space shuttle The tank holds 139,623 gallons of liquid oxygen and 378,300 gallons of liquid hydrogen.

You are about to descend.

As Mission #6 "draws" near the end.

READ: (or listen to the tape and follow along)

"MOONWALK AND BEYOND"

by

Isaac Asimov

THEN. .

DREAM UP YOUR VERSION OF A SHUTTLE

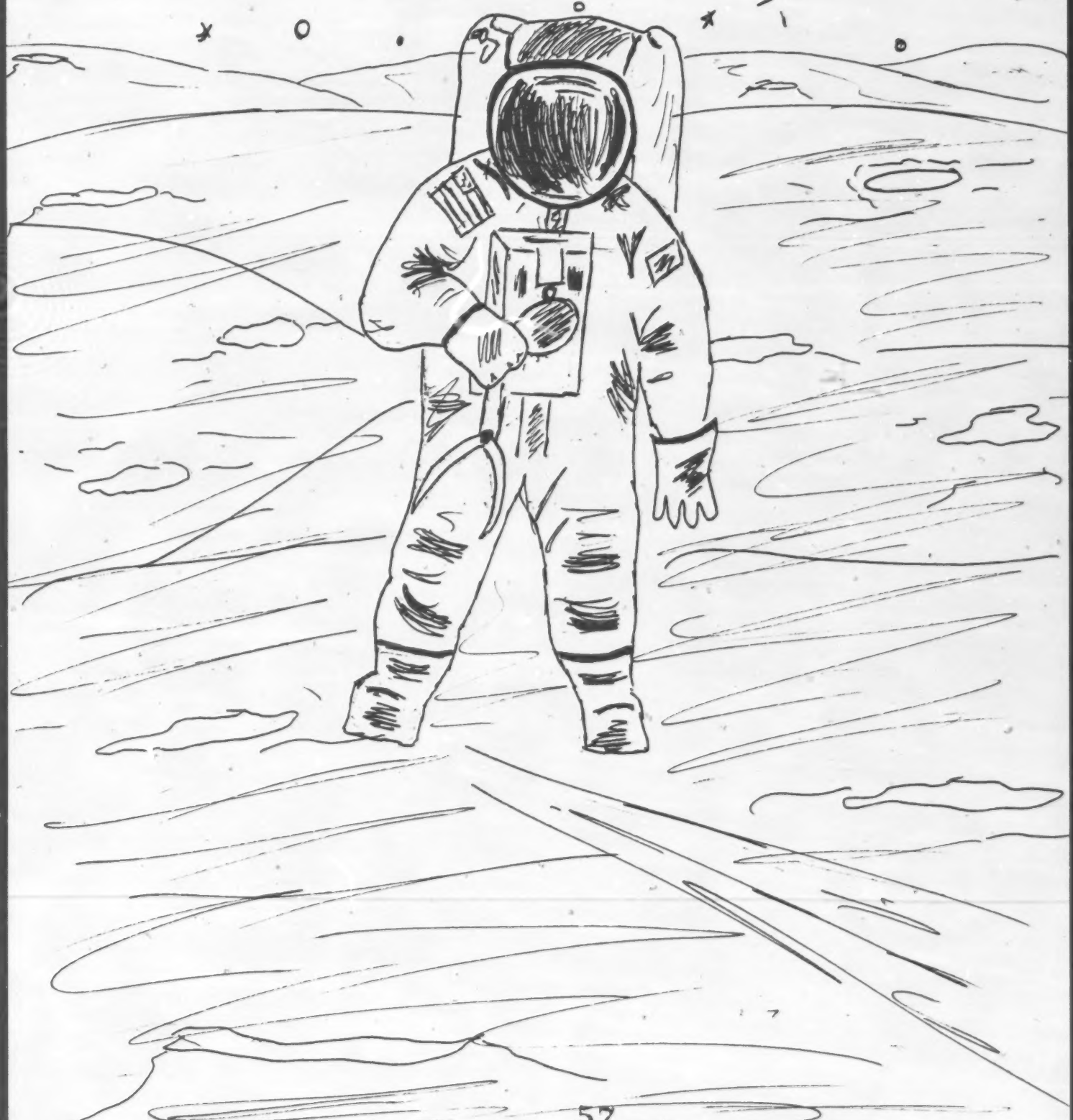
Use art paper and your crayons

OR

Build a Shuttle, recycling materials provided at the Space Center.

MOONWALK

22



Moonwalk—and beyond

How fares man's journey to the stars?

by Isaac Asimov

A DECADE has passed since human footsteps first were impressed on the Moon, and it has been a busy decade indeed for space exploration.

In increasing numbers and sophistication, satellites have circled the Earth, studying its cloud cover and its weather patterns, its physical nature, and its balance of resources. (It's hard to realize that, only 25 years ago, it was almost impossible to tell when and where a hurricane would strike till the last minute. If you wonder what value space research has, consider the lives and property saved in recent decades by the accurate monitoring, from space, of hurricanes.)

A mere footprint, yet it was the culmination of an awesome technological drive to step beyond the boundaries of Planet Earth. We have traveled to the moon. Will we arrive on planets during the next decade of space exploration.

Probes have been sent outward to map the craters of Mercury, the volcanoes of Mars and Io, the streaks on Europa, the dirt-covered icy surfaces of Ganymede and Callisto, the striations on Phobos, and the sands of Deimos.

The whirling contortions of Jupiter's atmosphere are on film, and the finest details of Venus's thick, poisonous, nearly red-hot atmosphere are on record. The Martian surface has been photographed from space and from the surface itself, and its soil has been handled and tested.

All of this represents knowledge. It represents knowledge in the abstract and that pleases scientists. Knowledge, however, no matter how abstract, has a curious habit of becoming useful.

Here's one possible example. Venus's hellish temperatures seem to be the result of a "runaway greenhouse effect" inflicted on a planet that has, after all, the size, mass, and constitution of our own. What triggered off that effect on Venus and what prevents the same triggering on Earth? Is there anything humanity might do that would start the deadly process on Earth? Knowing all we can know about Venus may help guide our actions to keep us from unwittingly making our own planet uninhabitable some day.

The rule applies to knowledge about the planetary worlds generally. As long as we know only Earth in detail, we don't really know much. Let us learn a great deal about a dozen worlds, different in size, in temperature, in composition, in rotation, and we may become more enlightened about Earth itself, about its past and its future.

Yet the unmanned probes, however dramatic their results, don't represent what we all feel to be the *true* space effort—the emergence of humanity into space and the establishment of a space-oriented society. That seems to have come to a halt. We reached the Moon several times then went no further. We even stopped going to the Moon.

Ah, but those trips were primitive. They resembled Lindbergh's nonstop flight across the Atlantic in 1927. That was dramatic and heartwarming, but it did not represent, in itself, the commercial possibility of routine air-travel over the oceans. For that, there had to be years of further development, and it wasn't until the building of jet-planes 25 years after the flight that routine travel by air put an end to the great days of ships and trains.

The decade since the first landing on the Moon has seen crucial developments toward a new and much more efficient reach into space. For one thing, careful tests have been made both by the United States and the Soviet Union to see how long human beings could withstand gravity-free conditions without serious harm. Little by little, the length of exposure was extended and now it is quite certain that human beings can remain in space continuously for as long as 100 days and yet readjust to Earth's surface conditions without undue difficulty. This means human beings will be able to work in space for prolonged periods of time, and that in turn improves the prospects for the commercial applications of space.

Work in space must, of course, be made less expensive. Up to this point, every manned venture into space has been by way of a space vessel that was good only for that one venture. This has made space flight enormously costly. Now, however, the United States has devised the Shuttle, a spacecraft that can be used and re-used up to 100 times. [See *Enterprise: Taxicab to Space*, THE ROTARIAN

Right: U.S. astronaut Edwin E. "Buzz" Aldrin, the lunar module pilot of the Apollo mission, walks near the space vessel during an "extravehicular activity" on July 20, 1969. This photograph was taken by Neil A. Armstrong, commander of the historic expedition.

for June 1978—Eds.] Through its re-use, the cost of space-flight will plummet. Undoubtedly, the Space Shuttle will be improved, and more durable and versatile models will be built in the future.

Whereas, in the early 1970s, one-shot vessels carried astronauts (three at a time) to brief tasks on the Moon at great expense; in the 1980s (it is to be hoped) fleets of Shuttle-craft will carry, at reasonable cost, dozens, perhaps hundreds, of specialists of all kinds into space for extended stays during which they will put together elaborate space-stations out of prefabricated parts also sent upward by shuttle.

Once space-stations are constructed and staffed, they will form a better base for the further exploitation of space than the surface of Earth possibly can. Vessels can leave the stations without interference by an atmosphere and with much less in the way of energy requirements for the overcoming of gravity. It would thus become cheaper still, and easier, to carry on.

From the space stations as nerve centers, the crucial space structures will begin to be built. There will be large solar power stations turning square kilometres of photoelectric cells to the Sun under conditions in which Earth's shadow will interfere with the collection for only two percent of the time, and the interference from atmosphere will be zero.

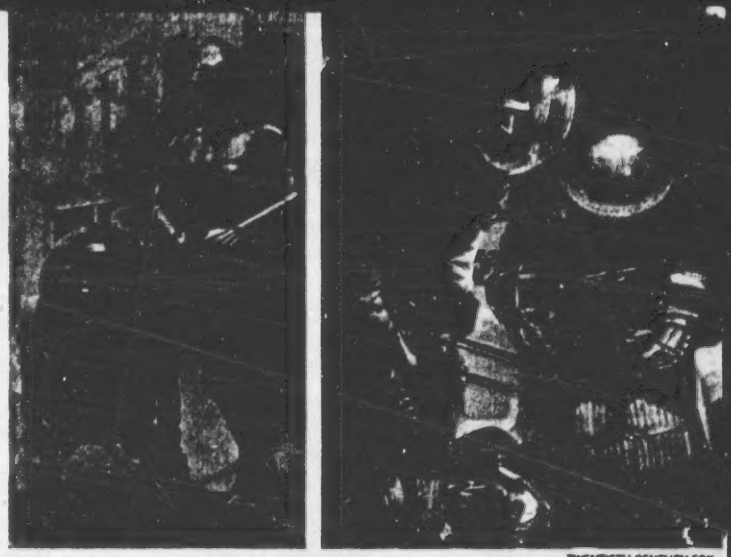
To help build such solar power stations (which may permanently solve Earth's energy needs), we will want a mining station on the Moon; Earth's plundered resources must be conserved where possible. This means that when we return to the Moon, under much more commercial conditions, it will be to *stay*, with large numbers of people serving long tours of duty.

The Moon's soil (smelted in space) can supply all the metals we need—glass and concrete, even soil and oxygen. All this can, in turn, be used to build much larger space stations—stations large enough to be called space settlements. Such settlements might support from ten thousand to ten million people and, if made to rotate, would simulate an Earth-type gravitation on their inner surfaces by setting up a centrifugal effect. Considering their size and their gravitation, a very Earth-like environment can be set up within them and, for the first time, it would become possible to think of people living permanently in space, of being born there and of dying there.

These space settlers will be the pioneers of the 21st century and it will be they who will lead the further development of space. After all, once European settlers established a nation in North America, it was not European expeditionary forces that developed the continent, it was the Americans themselves.

The settlers accustomed to a space environment will continue to build solar power stations in space for themselves as well as for Earth.

They will build observatories in space where the secrets of the universe can be unlocked without the difficulties introduced by Earth's quivering, absorbing, and dirty atmosphere. They will build laboratories in space where



TWENTIETH CENTURY-FOX

Far out? Maybe not. As man's space technology improves, these scenes from "Star Wars" (left) and "Alien" (right), two recent science fiction films, may one day have real-life counterparts.

dangerous work (nuclear power production, recombinant-DNA experimentation, and so on) can be carried on with all due precautions—and with the knowledge that if an accident does occur, damage will be confined to the space-laboratory itself and will not needlessly involve population centers.

They can build factories that can make use of the unique conditions of space—zero-gravity, hard vacuum, high and low temperatures, energetic radiation, endless room for pollution dispersal—to do things that are difficult or impossible on Earth's surface.

The space settlers will be the explorers of the future. Accustomed to space and to the very notion of space-flight, they will be much better suited, psychologically, to withstand long flights than would be those human beings who are prisoners of Earth's surface.

It will surely be the space settlers who will undertake the long flights to Mars, the asteroids, and beyond. The asteroid region will, in fact, serve as a new home, since the asteroids themselves are sources of material that will include the crucial light elements of carbon, hydrogen, and nitrogen which the Moon itself cannot supply.

There will be far more room in the asteroid region than in the vicinity of the Earth; room for thousands of times as many space settlements and thousands of times as many people.

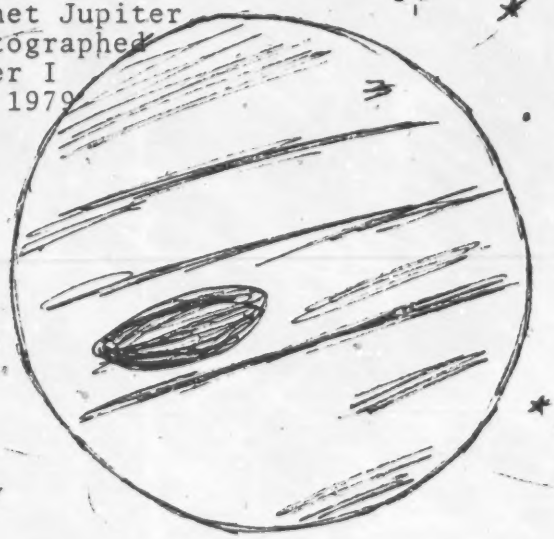
And finally, these settlements may take off altogether, using advanced means of propulsion we cannot even dimly predict, and drift outward endlessly toward the far stars.

Ten years ago we reached the Moon. Well, if Earth does not lose its nerve—you ain't seen nothin' yet! ●

● *Scientist, novelist, critic, poet, prophet, raconteur: Isaac Asimov is a Renaissance man of the future. Author of more than 200 books on all manner of topics, he has undoubtedly written at least one more between the time this biography was written and the time it was published. For more information on this remarkable man—and a photo—see the* By the Way column, *page 2.*

An artist's concept of a space industrial facility in earth orbit. Space Shuttles will transport raw materials and finished products to and from the "floating worlds."

The planet Jupiter as photographed by Voyger I Feb. 1, 1979



The multipurpose Space Shuttle will be an efficient, reusable bridge between Earth and its extraterrestrial outposts.

HIS BUSINESS card reads "Isaac Asimov . . . Natural Resource." And it's true. Biochemist, prolific writer of fact and fiction, and critic-at-large of society, Isaac Asimov is a truly remarkable person. THE ROTARIAN is proud to add his illustrious by-line to our list of contributors.

For this issue, we asked Dr. Asimov to write about only one of the subjects he knows well—space exploration.

It was 10 years ago—on July 29, 1969—that U.S. astronaut Neil Armstrong became the first earthman to set foot on the moon, culminating one of the most ambitious and complicated enterprises in human history. At the time, it seemed as if man were embarking on a spectacular new phase in his understanding of the universe and opening a bold new chapter in the annals of exploration. If man could reach the moon, then he could get to the stars.

Ten years after the moonwalk, we have not yet arrived at the stars. Many of the dreams for space travel are still unrealized, and space programs have been scaled down. Yet some dramatic achievements have occurred, and Dr. Asimov writes about them in this issue. In *Moonwalk—and Beyond* (page 20) he considers the manifold implications of man's arrival on the moon, the first steps in an awesome journey.

Dr. Asimov was born in Petrovich, Russia, in 1920. Three years later his family emigrated to the U.S. At age 16 he left high school and began studying chemistry at Columbia University in New York City. While studying science he began writing science fiction. His first story, "Marooned Off Vesta," was published in 1939. This was the beginning of an amazing literary output, which now numbers more than 201 books.

He received a Ph.D. in chemistry in 1948. The next year he joined the faculty of Boston (Massachusetts) University as an instructor, eventually rising to the rank of associate professor of biochemistry. In 1958 the good doctor left the groves of academe to take up a full-time writing career.

And write he does, producing a new book every four months. Isaac Asimov is best known for his science fiction (SF) novels and stories, and is regarded as one of the brightest lights in the galaxy of speculative fiction. Among his most famous SF titles are the "Foundation" trilogy—"Foundation," "Foundation and Empire," and "Second Foundation"—"Pebble in the Sky," "Caves of Steel," "The Naked Sun," "I, Robot," and "The Gods Themselves."

A popularizer of science, he has penned many highly regarded nonfiction works, such as "The Intelligent Man's Guide to Science." Earlier this year he published his autobiography, "In Memory Yet Green" (Doubleday, New York, $15.95).

ALEX GOTFRYD

Dr. Isaac Asimov

SECTION II

SHUTTLE "CAN DO"

AWAITING "LIFT-OFF"

AT THE SHUTTLE LEARNING CENTER, YOU WILL FIND A SHUTTLE WHICH CONTAINS "PAYLOADS" FOR YOU.

CHOOSE ANY FIVE TO DO!!!!

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